Rule 21 Group 2 Working Group Meeting

April 4, 2018

Topics

- ICA Road Map
- What is Integration Capacity Analysis (ICA)
- Components of ICA
  - 2018 requirements based on Track 1 PUC ruling
    - Thermal
    - Steady State Voltage (SSV)
    - PQ/Voltage Fluctuations
    - Protection
    - Operational Flexibility
- ICA Publishing
  - ICA/Load values

ICA Road map

- ***2013 - AB327 is passed –*** among other requirements, the bill "would require an electrical corporation, by July 1, 2015, to submit to the commission a distribution resources plan proposal, as specified, to identify optimal locations for the deployment of distributed resources"

- ***August 14, 2014 –*** PUC issues a rulemaking decision which stablishes the policies, procedures and rules on how IOUs should develop the Distribution Resource Plan (DRP)

- ***February 2015 –*** Assigned Commissioner Ruling (ACR) was issued which provided DRP guidance on the DRP which IOUs must file by July of 2015

- ***July 2015 –*** IOUs file DRPs which included a version of ICA maps based on directional methodologies (Streamline, representative circuits, etc.)

- ***August 2016 -*** PUC ruling DRP outlining the requirement for several demonstration projects. One of these demonstrations was Demonstration A (DEMO A) which would demonstrate two ICA methodologies as well as publishing of data for two Distribution Planning Areas (DPAs)

- ***December 2016 –*** IOUs complete demonstration project A, publish maps with ICA information, and provide circuit loading and criteria limitations as required by DEMO A for two DPAs

- ***October 2017 –*** PUC ruling on Track 1 Demonstration Project A provides ruling on which ICA methodology is to be used for system 2018 system wide deployment of ICA and requires that this be completed by July 2018 (focus on Interconnection Use Case)

What is Integration Capacity Analysis

- Also known or referred to as “Hosting Capacity Analysis” in several forums and research work activities
  - Not all hosting capacity is created the same

- The methodology used will specify how much DER hosting capacity may be available on the distribution network down to the line section or node level (DRP Guidance)

  Example for SCE

  - ***Approximately average of 600 nodes per feeder, 576 hours and several categories***
  - ***Approximately 10 billion data points***

- This analysis quantifies the capability of the distribution system to integrate DER within thermal ratings, protection system limits and power quality and safety standards (DRP Guidance)

- Perform an analysis using dynamic modeling methods using power flow modeling software tools and with heuristic approaches only when necessary (DRP Guidance)

Detailed ICA System Wide Implementation

Summary of final decision (Track 1) Issued Oct 2017

- ICA results are to be update on a monthly basis based for changes in circuits:
  - Circuits which have changed (configuration, new line sections)
  - Circuits which have changed loading (new load, load reduction, change in load profile)
  - Circuits which have new “significant” DER interconnected

- 576 hourly load profiles are to be used (Peak and minimum day for each month 24*2*12= 576 hours)

- Publish six ICA values on the maps (uniform generation, uniform load, Fixed solar PV)
  - Three with Operational Flexibility Limitation
  - Three without Operation Flexibility Limitation

- Data for ICA categories must available for download by the user

- Calculated ICA values must account for pre-existing conditions (Ex. Low voltage should not restrict generation ICA, High voltage should not restrict Load ICA)

- Used technology-agnostic approach which does not make assumptions on DER portfolios. Users can utilize an ICA translator to convert the uniform generation value to any type of DER technology.

- Include attributes circuit & substation ID, line section ID, Voltage, existing, queued and total generation, circuit and substation load profiles when confidentiality is not compromised, customer class breakdown

What is Considered/Included in ICA Calculations

1. ICA for all three phase nodes and line sections radial distribution feeders (circuits)
2. Account for feeder's electrical components Thermal Loading limitations (cable, conductor, VRs, etc.)
3. Account for deviations is Steady State Voltage (SSV) throughout the feeder.
   Injecting real power at one node must not overvoltage other ports of the circuit(s)
4. Impacts of DER to Protection systems. *Injecting DER at one node must not desensitize the relay to a point that it cannot effectively protect the system*
5. Impacts of DER to Voltage Fluctuations and Power Quality(PQ). *The value of ICA must be limited to not create significant voltage changes in system voltage*
6. Impacts of DER to Operational Flexibility. *The level of DER connected limited to not inhibit the ability to reconfigure the distribution system as necessary for operations*

   Two values are determined

   1. ICA values not accounting for Operational Flexibility
      ICA With **N**o **O**perational **F**lexibility(**ICAWNOF**)
   2. ICA values accounting for Operational Flexibility
      ICA With **O**perational **F**lexibility(**ICAWOF**)

What is Not Considered or Included in ICA Calculations

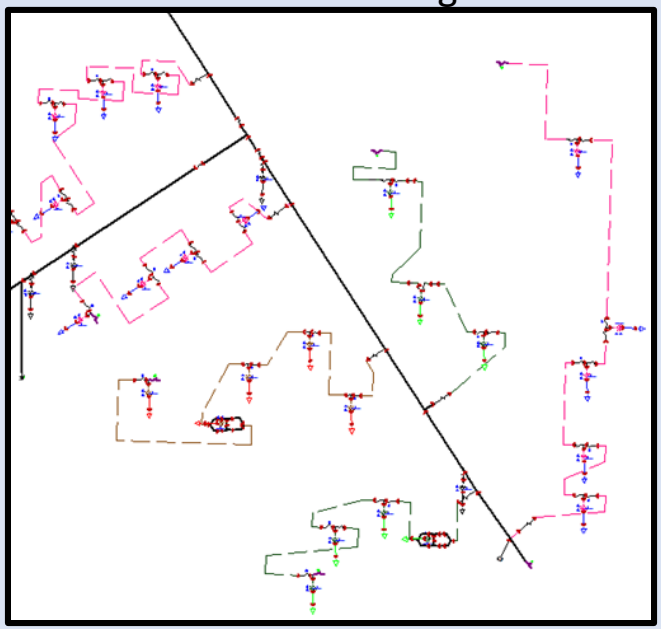
1. Substation Level ICA limitations(Txfmr Banks, busses, CBs)
2. Subtransmission/Transmission Limitations
   - Stability/Capacity
3. Secondary Networks
4. Secondary systems, service drops, service transformers
5. ICA values for rotating machine (Synchronous or Induction Generation)
   a. ICA uses 1.2p.u SCD contribution which is for inverter based technology
6. Single Phase radials
7. Smart Inverter functionality – Volt/Var with reactive power priority
   a. Pending PUC decision
   b. Pending tool development advancements
8. All PV system configuration– PV ICA only addresses PV installation equivalent to what was used in PV-Watts® when determining regional PV profiles
   a. Does not address tracking systems, inverters limit output, etc.
9. Technology specific ICA – (Customer may use the uniform ICA values with translator to develop technology specific ICA values)
   1. PV+ storage, PV with trackers, peak shaving storage, etc.

Thermal ICA value

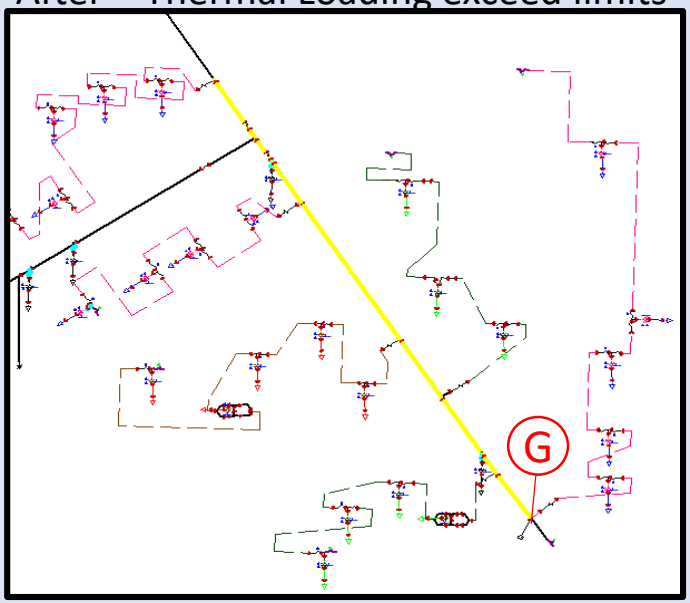
What it is: The maximum amount of load or generation ICA which can be connected to a node without exceeding the thermal value of any conductor or apparatus in the feeder.

How is it derive: Iterative power flows are used to determine the maximum value which can be connected at each node before a thermal overload occurs. (in this example – CYME is programed to show Yellow when thermal loading is exceed .

Before – Thermal Loading within limits



After – Thermal Loading exceed limits

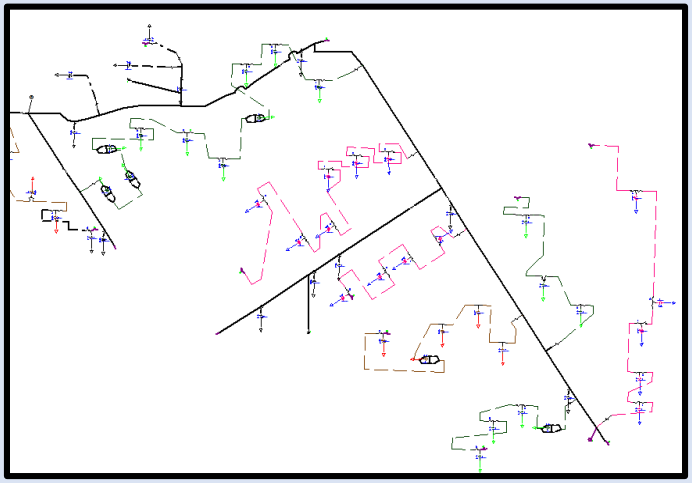


Steady State Voltage (SSV) ICA value

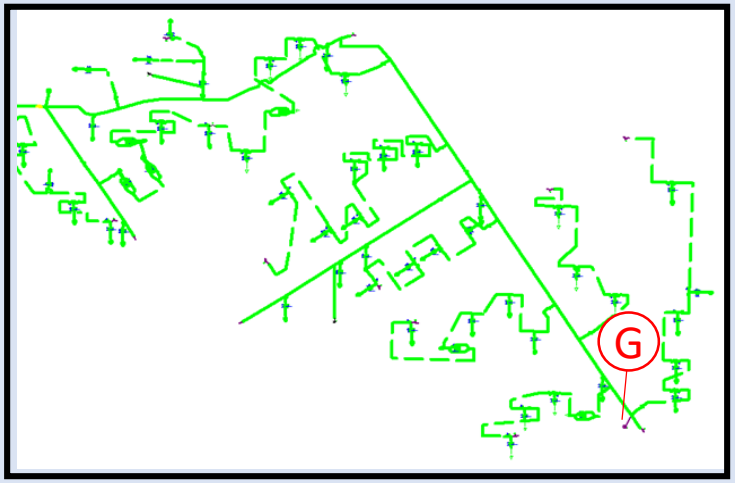
What it is: The maximum amount of load or generation ICA which can be connected to a node without moving the voltage at any part of feeder outside the range of +/-5% of nominal (For 120V, the range would be 114V to 126V)

How is it derive: Iterative power flows are used to determine the maximum value which can be connected at each node before the voltage deviates from the range (in this example – CYME is programed to show **green** when threshold is exceed .

Before – Voltage within thresholds



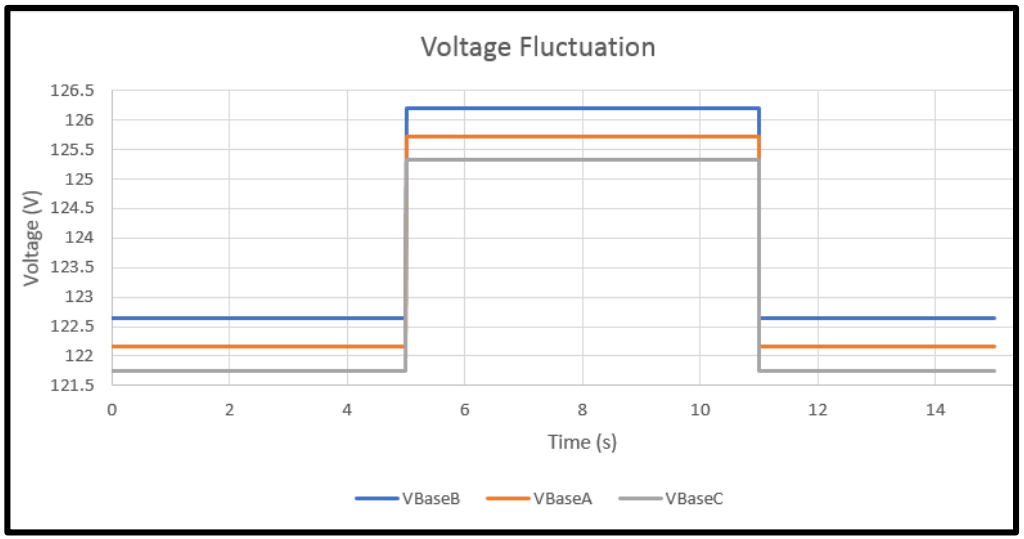
After – Voltage exceeds thresholds



PQ/Voltage Fluctuations

What it is: The maximum amount of load or generation ICA which can be connected to a node without changing the voltage by more than 3%.

How it is derived: The ICA power flow tool will simulate the DER turning on and turning off and will compare the voltages before and after to determine change in voltage and % change.



$$\% \triangle = \| (Va - Vb)/Vb * 100$$

Where
Vb = Voltage measurement with DER **off**
Va = Voltage measurement with DER **on**

Example (from Graph)
Vb=121.575
Va =125.25

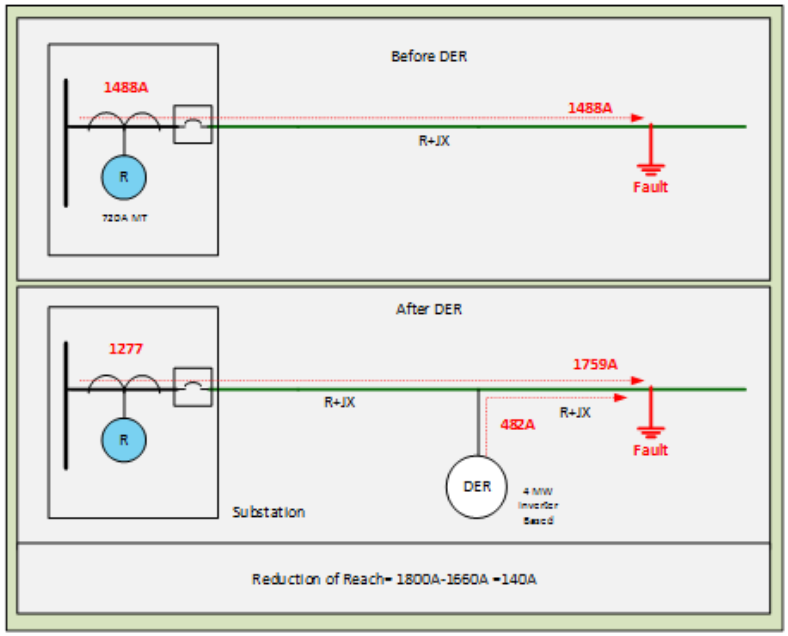
$$\% \triangle = \frac{125.25 - 121.575}{121.575} * 100$$

$$\% \triangle = 3.0\% \text{ (Maximum ICA limit)}$$

Protection ICA Value

What it is: The maximum amount of load or generation ICA which can be connected to a node without reducing the protection device's ability to detect faults. This is also referred to as reduction of reach.

How it is derived: The ICA power flow tool performs a fault flow analysis to evaluate the reduction in fault current flow at the protection sensing devices due to DER being connected downstream from the protection sensing device. ICA is limited to when DER reduces fault at sensing relay to less then 2.3*Minimum Trip Setting



Before – Meets Criteria

Fault Current seen by Prot. Dev. (A)	Fault Current (A)	Protected
1488.54	1488.57	Yes

MT=600
Multiple =1488/600
=2.48 (meets ICA criteria)

After – Fails Criteria

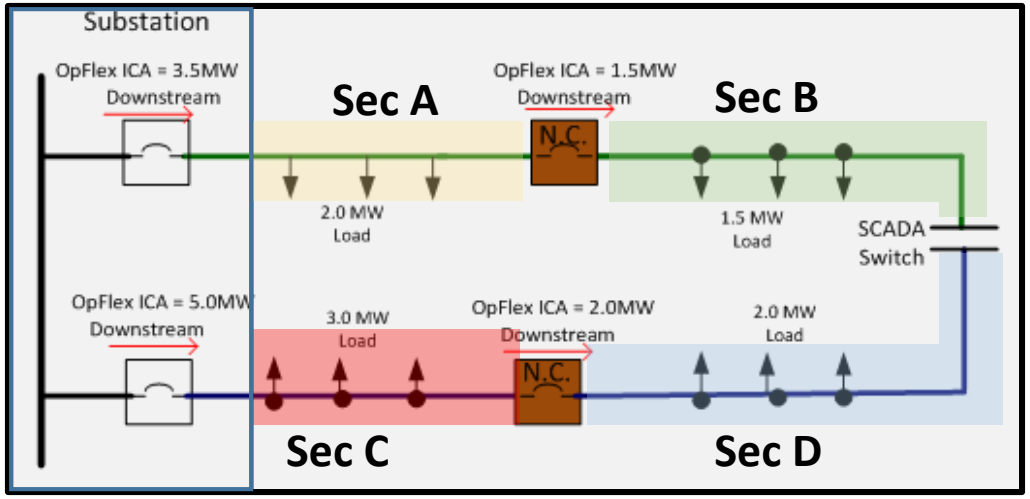
Fault Current seen by Prot. Dev. (A)	Fault Current (A)	Protected
1277.1	1759.89	No

MT=600
Multiple =1277/600
=2.12 (Fails ICA criteria)

ICA With Operational Flexibility ICA value (ICAWOF)

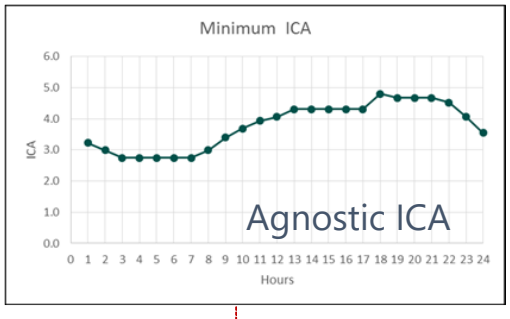
What it is: The maximum amount of load or generation ICA which can be connected to a node without exceeding loading beyond an automated SCADA switching devices

How it is derived: The ICA power flow tool determined the amount of load connected beyond the automated SCADA switching device. The ICAWOF value is limited to the amount of load beyond the SCADA switching device.

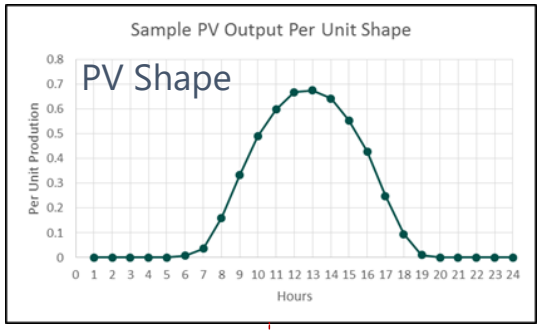


Section	ICAWOF
A	3.5MW
B	1.5MW
C	5.0MW
D	2.0MW

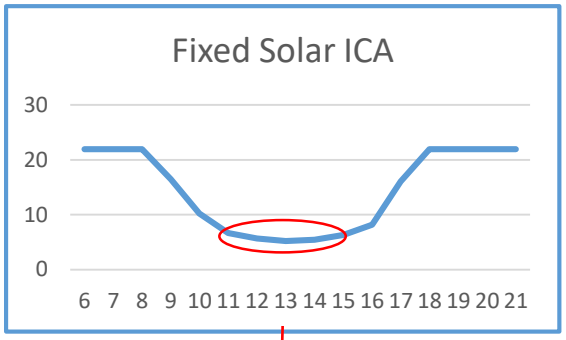
Typical Fixed PV ICA Value



+



=



ICA Value – From

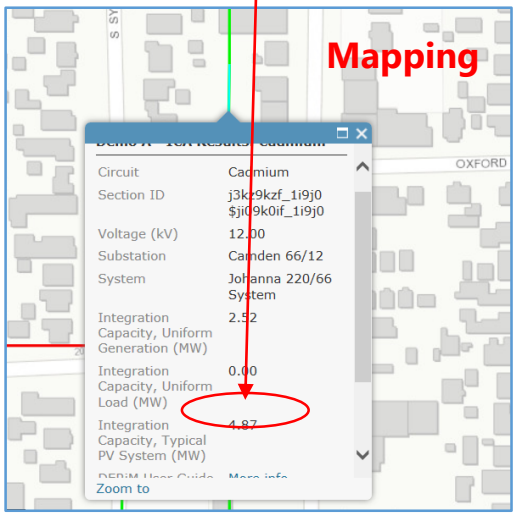
- Thermal
- Voltage
- PQ/Voltage Fluctuations
- Protection
- System Flexibility

- Typical PV shape from PV-Watts Tool
- 95th percentile curve

PW Watts Parameters

- DC size = Normalized to 1.0
- Module Type = Standard
- System Losses = 14%
- Tilt = 18 Degrees
- DC-AC ratio = 1.0
- Inverter Efficiency = 96%

THESE PARAMENTERS MUST BE CONSIDERED



PG&E SDGE SOUTHERN CALIFORNIA EDISON An EDISON INTERNATIONAL Company

ICA Values Publishing (Example)

The following ICA Generation values are calculated for a particular 3 phase node

Thermal (MW)	SSV(MW)	PQ (MW)	Protection (MW	Op-Flex (MW)
3.5	**3.76**	**5.9**	**6.5**	**2.75**

(1) Uniform Generation **ICA W**ith **O**peration **F**lexibility (ICAWOF)

$$ICAWOF = lower(Thermal, SSV, PQ, Protection, Op - FLex) = \mathbf{2.75\ MW}$$

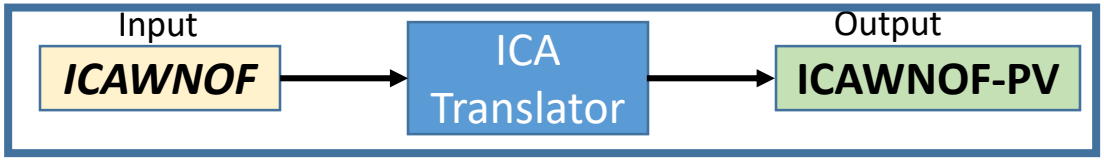
(2) Uniform Generation **ICA W**ith **N**o **O**peration **F**lexibility (ICAWNOF)

$$ICAWNOF = lower(Thermal, SSV, PQ, Protection) = \mathbf{3.5MW}$$

(3) Fixed Solar PV **ICA W**ith **O**peration **F**lexibility (ICAWNOF - PV)

ICA translator developed from PV Watt ® tool at the regional level

(4) Fixed Solar PV **ICA W**ith **N**o **O**peration **F**lexibility (ICAWNOF - PV)

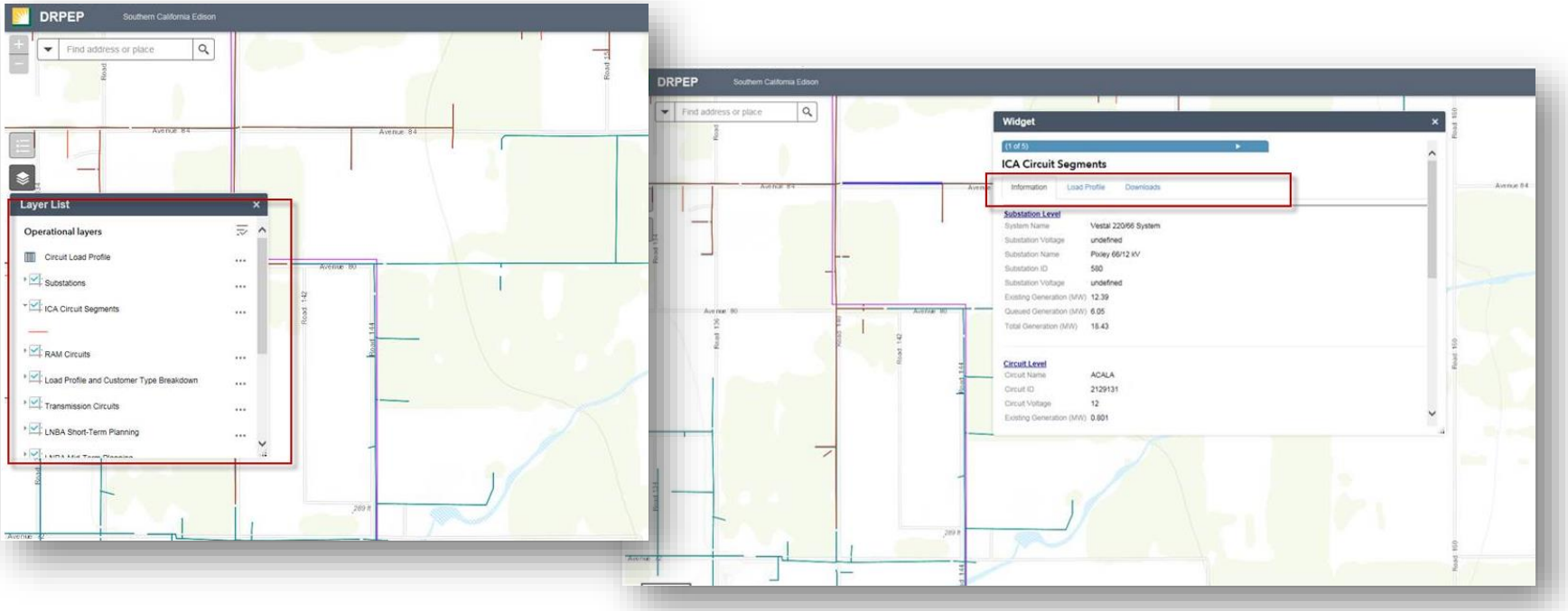


ICA translator developed from PV Watt ® tool at the regional level

(5 & 6) Load ICA. Same both With and Without Operational flexibility

Publishing – ICA Results (SCE Platform)

Deployment	Functionality
July 2018	Publish system-wide ICA to public

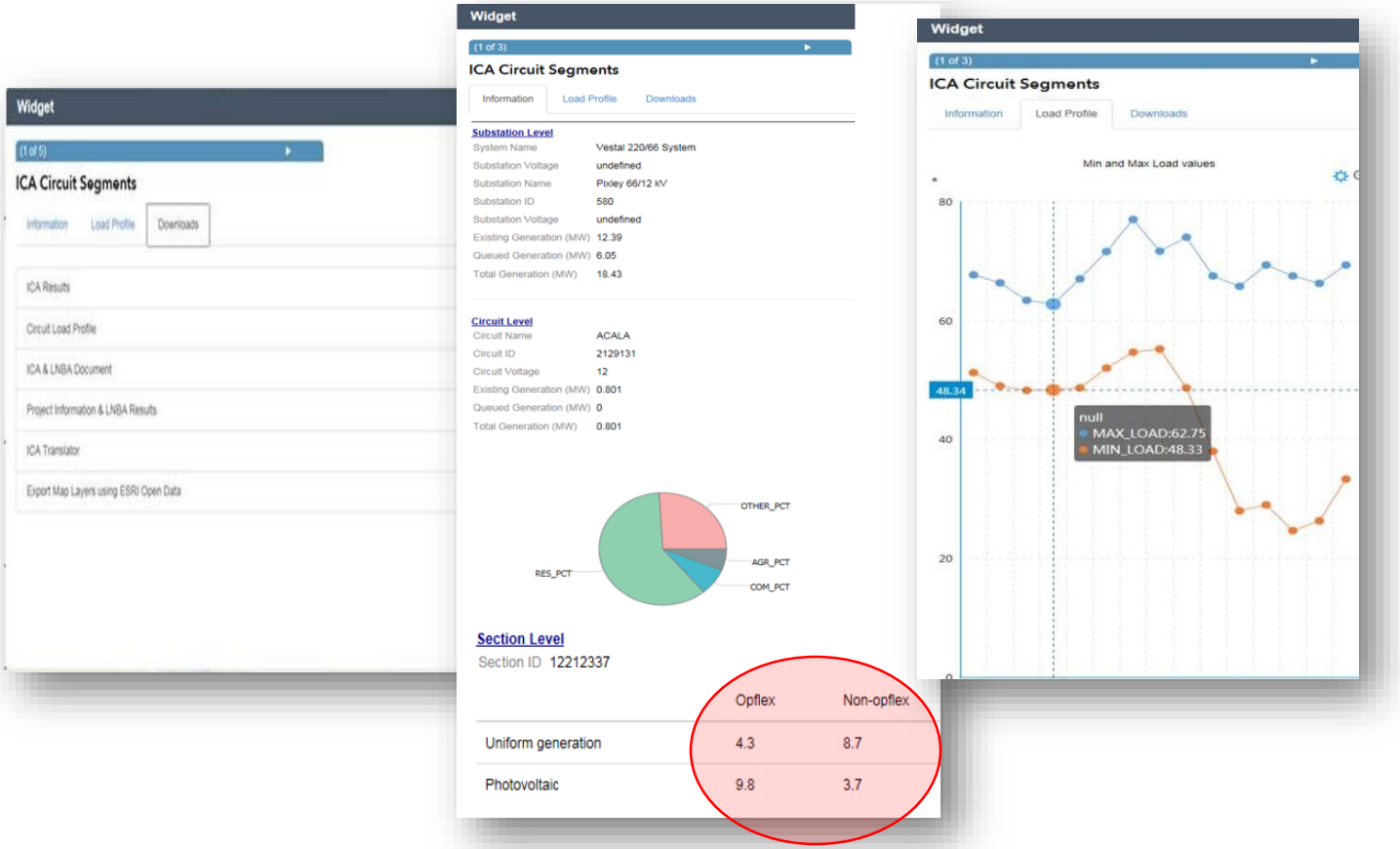


Tool – DRP External Portal (DRPEP)

- User can select the desired Layer – **Will be defaulted to ICA layer**
- User can select to view the circuit and loading profiles
- Use can download information
- **All Demo A layers and information will be removed once system wide has been deployed**

Publishing – ICA Results (SCE Platform)

Widget Functionality to Publish Required Datasets



- **ICA Results**
- **Substation/circuit level information**